BYU Law Review

Volume 1983 | Issue 4 Article 3

11-1-1983

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Charles L. Deem

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Recommended Citation

Charles L. Deem, *Liability of Private Space Transportation Companies to Their Customers*, 1983 BYU L. Rev. 755 (1983).
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COMMENTS

Liability of Private Space Transportation Companies to Their Customers

I. INTRODUCTION

The recent development of the United States space shuttle marks a new era in the commercial use of outer space.[1] Although the shuttle is currently being operated by the federal government, the new space transportation system will result in greater use of space by private industries.[2] The technological benefits and economic advantages of these commercial operations in space will lead to the development of private space carriers so that in the near future businesses will replace governments in the operation of space transportation systems. Numerous legal issues will accompany the entry of private enterprise into space. One legal issue that must be resolved is the nature of liability of a space carrier for damage caused to its customers' goods.

Drawing on analogies from the law of air carriers and from international space law, this Comment will suggest that the liability of a space carrier to its customers should be based on a negligence standard rather than on the doctrine of strict liability for abnormally dangerous activities. This Comment will also show that because they will not be considered common carriers subject to special responsibilities, space carriers should be held to the traditional standard of ordinary care. Additionally, space insurance firms, perhaps in conjunction with governmental limitations of liability, are prepared for contractual limitations of liability imposed on private space carriers because the space in-

1. *See generally* H. ALLAWAY, THE SPACE SHUTTLE AT WORK (1979) (NASA publication describing the United States space shuttle system and its capabilities).

2. *See infra* notes 33-56 and accompanying text. *See generally* COMMERCIAL OPERATIONS IN SPACE: 1980-2000 (J. McLucas & C. Sheffield eds. 1981) (collection of articles discussing the potential uses of space in the coming decades); FUTURE SPACE ACTIVITIES (C. Tross ed. 1976) (collection of articles discussing future planetary missions and space industrialization).

surance industry has already developed within the framework of total governmental exclusion of liability. Finally, this Comment will suggest that government regulation of the private space carrier industry should be utilized to encourage the development of commercial operations in space as well as to regulate the industry.

II. Historical Development: Governmental Space Transportation Systems

Historically, the exploration and use of space have consisted primarily of experimental activities conducted by the governments of the Soviet Union[3] and the United States.[4] The Soviet Union brought the world into the space age on October 4, 1957, with the launch of Sputnik 1, a 184-pound artificial satellite containing chemical batteries and radio transmitters sending back to earth data on temperatures, cosmic rays, and micrometeoroids. [5] Nearly four months later the United States launched its first artificial satellite.[6] In these early days of the space age both countries established permanent space organizations to coordinate their space programs.[7]

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3. *See generally* N. Johnson, Handbook of Soviet Manned Space Flight (1980) (discussion of the Soviet manned space program from the 1957 launch of Sputnik 2 manned by a dog named Laika to the missions aboard the Salyut 6 space station from 1977 through 1980); C. Sheldon, Review of the Soviet Space Program 46-78 (1968) (discussion of the Soviet Union's space program from the 1957 launch of Sputnik 1 through the death of Vladimir Kamarov aboard Soyuz 1 in 1967); W. Shelton, Soviet Space Exploration: The First Decade (1968) (discussion of the Soviet space program from the launch of Sputnik 1 in 1957 to Kamarov's death in 1967).

4. *See generally* W. Shelton, American Space Exploration: The First Decade (1967) (discussion of the United States space program from the early Atlas rocket failures in 1957 to the Apollo fire in early 1967); Emme, *Presidents and Space*, in Between Sputnik and the Shuttle: New Perspectives on American Astronautics 5 (F. Durant ed. 1981) (discussion of the role of the White House for the first twenty-five years of the United States space program from the approval in 1955 of an earth satellite for the International Geophysical Year to the space transportation era of the space shuttle in the 1980's); Faget, *An Overview of United States Manned Space Flights From Mercury to the Shuttle*, in Space: Mankind's Fourth Environment 3 (L. Napolitano ed. 1982) (discussion of the United States Project Mercury, Gemini Program, Apollo Program, Skylab Program, Apollo-Soyuz Test Project, and the Space Sbuttle Program).

5. W. Shelton, *supra* note 3, at 57-58. See C. Sheldon, *supra* note 3, at 90, for a drawing of the Sputnik 1 satellite.

6. Explorer I, the United States' first satellite, was launched on January 31, 1958. The satellite weighed only eighteen pounds but carried the experiment of Dr. James A. Van Allen that identified radiation belts around the earth. E. Emme, A History of Space Flight 125, 133 (1965).

7. The exact nature of the Soviet space organization has never been clear to observers outside the Soviet Union. The Soviet Academy of Sciences plays at least an advisory

After these early launches of man-made satellites the Soviet Union and the United States conducted a series of tests to determine the feasibility of carrying life into outer space.[8] Following these tests both countries entered a series of manned and unmanned projects demonstrating man's ability to explore and utilize outer space for the benefit of mankind. Working independently,[9] the Soviet Union and the United States developed the technology necessary to enable man's entry into outer space. Thus, from the beginning the exploration and use of space were functions of national governments.

III. Currently Operational Space Transportation Systems

A. Comsat-Intelsat Satellite System

Private commercial interests became directly involved in space when the United States Congress passed the Communications Satellite Act of 1962.[10] The Act authorized the creation of the Communication Satellite Corporation (Comsat) which was organized as a private corporation for profit rather than as an agency of the United States Government.[11] The corporation is owned jointly by private investors and various communications

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function in the program while Soviet strategic rocket troops conduct the actual launches. C. Sheldon, *supra* note 3, at 79. In the United States the Department of Defense initially supervised the space program. Later, the Advanced Research Projects Agency coordinated the program. Finally, the National Aeronautics and Space Administration was formed to manage the United States space program. *Id.* at 79-80.

8. After initial rocket launchings of mice, frogs, and dogs, the Soviet Union launched the dog Laika into orbit in late 1957. W. Shelton, *supra* note 3, at 65-69. Several other dog launches occurred throughout 1960 and 1961. C. Sheldon, *supra* note 3, at 16. The United States launched several biological payloads between 1958 and 1961 including animals such as mice, monkeys, and a chimpanzee. *Id.* at 18.

9. The United States and the Soviet Union did conduct a joint manned space mission in the 1975 Apollo-Soyuz Test Project. The project led to the development of a new universal docking mechanism to be used on the joint mission and future spacecraft of each country. N. Johnson, *supra* note 3, at 175.

10. 47 U.S.C. §§ 701-757 (1976 & Supp. V 1981).

11. *Id.* § 731. The purpose of the corporation is threefold, to

> (1) plan, initiate, construct, own, manage, and operate itself or in conjunction with foreign governments or business entities a commercial communications satellite system;
>
> (2) furnish, for hire, channels of communication to United States communications common carriers and to other authorized entities, foreign and domestic; and
>
> (3) own and operate satellite terminal stations when licensed by the [Federal Communications] Commission under section 721(c)(7) of this title.

Id. § 735(a).

companies.[12] The National Aeronautics and Space Administration (NASA) works closely with Comsat to provide the corporation with satellite launching and associated services.[13] Thus, although Comsat is a private corporation in the business of establishing a communications satellite system, it must rely on an agency of the United States Government to launch its satellites.

One of the first major functions of Comsat was to develop a global communications satellite system.[14] In 1964, after two years of discussions, fourteen countries signed an agreement calling for the creation of a global commercial communications satellite system.[15] Comsat represented the United States in the consortium and became manager of the International Telecommunications Satellite Consortium.[16] After operating as an interim undertaking for nearly ten years, the consortium formed a permanent organization in 1973 called the International Telecommunications Satellite Organization (Intelsat).[17] Intelsat now operates a sophisticated satellite system for its ninety-eight member countries and at least twelve nonmember users.[18] Although it is responsible for placing satellites in geostationary orbit, Intelsat must rely on other carriers to launch its satellites into orbit.[19]

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12. *Id.* § 734.

13. *Id.* § 721(b). Comsat pays NASA sixty percent of the cost for the launch service a month before the launch and the remainder a month afterward. *See* E. HOYT, THE SPACE DEALERS 168 (1971).

14. *See* E. HOYT, *supra* note 13, at 168.

15. Agreement Establishing Intarim Arrangements for a Global Commercial Communications Satellite System and Special Agreement, Aug. 20, 1964, 15 U.S.T. 1705, T.I.A.S. No. 5646. *See generally* Colino, *International Telecommunications Satellite Organization (INTELSAT)*, in 1 MANUAL ON SPACE LAW 363 (N. Jasentuliyana & R. Lee eds. 1979) (discussion of the historical development and organization of Intelsat).

16. *See* Laskin, *Background Paper*, in TWENTIETH CENTURY FUND TASK FORCE ON INTERNATIONAL SATELLITE COMMUNICATIONS, COMMUNICATING BY SATELLITE 19, 39 (1969).

17. International Telecommunications Satellite Organization (INTELSAT), Aug. 20, 1971, 23 U.S.T. 3813, T.I.A.S. No. 7532; *see* Astrain, *Growth of the Intelsat System*, in 2 USING SPACE—TODAY AND TOMORROW 1 (L. Napolitano ed. 1978).

18. Astrain, *supra* note 17, at 8.

19. One other telecommunications system worthy of mention is Intersputnik, an organization formed in 1971 by several socialist countries to facilitate satellite communications of member states. *See* Krupin, *The International Organization of Space Communications "Intersputnik,"* in 2 USING SPACE—TODAY AND TOMORROW 23, 23-25 (L. Napolitano ed. 1978).

B. National Aeronautics and Space Administration

NASA was formed in 1958[20] to consolidate the United States space program into a centralized, civilian, governmental agency.[21] Since then, NASA has conducted numerous manned and unmanned missions exploring outer space and its uses. Additionally, NASA has been responsible for research and development in the United States space program and in other high technology areas.[22]

For its first twenty years NASA developed expendable vehicles to carry payloads into space.[23] Comsat purchased launches on these expendable rockets when developing the global communications satellite system. As the size and weight of the payloads increased, NASA built larger and more powerful rockets.[24] Even with the advent of the space shuttle, eleven of NASA's sixteen launches for 1983 were planned with expendable vehicles.[25]

Although most of NASA's payloads were planned to be carried into space by expendable rockets in 1983,[26] a major emphasis of the agency's space program will be the further operational use of the space shuttle,[27] a major component of NASA's Space

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20. National Aeronautics and Space Act of 1958, 42 U.S.C. §§ 2451-2484 (1976 & Supp. V 1981).

21. *See* E. Emme, A History of Space Flight 125-38 (1965).

22. See National Aeronautics and Space Act of 1958, 42 U.S.C. § 2451(b)-(c) (1976), for a statement of NASA's research and development guidelines for the space program. Subsequent amendment of the Act has placed with NASA the research and development responsibility for ground propulsion systems, advanced automobile propulsion systems, and bioengineering research. *Id.* § 2451(d)-(f) (Supp. IV 1980).

23. *See* Disher, *Space Transportation: Reflections and Projections*, in Between Sputnik and the Shuttle: New Perspectives on American Astronautics 199, 199-215 (F. Durant ed. 1981).

24. *See generally* Grimes & Ganoung, *Delta's Role in Reaching the Fourth Environment*, in Space: Mankind's Fourth Environment 55, 55-66 (L. Napolitano ed. 1982) (discussion of the importance of the expendable Delta rocket in the United States space program).

25. *See Space Agency Schedules 16 Launches for 1983*, Aviation Week & Space Tech., Dec. 27, 1982, at 8, 8. Of the 11 launches with expendable vehicles, eight were planned with Delta rockets, two with Atlas Centaurs, and one with the Atlas E rocket. *Id.*

26. NASA expected to carry twenty-one payloads into space in 1983, eleven aboard expendable rockets and ten aboard five space shuttle missions. *Id.*

27. A NASA publication written by Howard Allaway has described the space shuttle as follows:

> The first true aerospace vehicle, the Shuttle takes off like a rocket, operates in orbit as a spacecraft, and lands like an airplane. To do this takes a complex configuration of three main elements: the Orbiter, a delta-winged spacecraft-aircraft, about the length of a twin-jet commercial airliner, but much bulkier, and built to last for at least 100 flights; a dirigible-like expenda-

Transportation System. As the first reusable spacecraft, the shuttle can deploy, repair, and retrieve satellites, operate space laboratories and telescopes, and carry materials for the construction of permanent space stations.[28] The shuttle orbiter's large weight and volume capacity and NASA's price schedule encourage commercial users to rent space on the shuttle for their payloads.[29]

C. *European Space Agency*

The European Space Agency (ESA) is an organization of European states formed in 1975 to strengthen European cooperation in space research and technology and to establish a long-term European space policy.[30] The agency is currently developing a space transportation system to launch payloads with expendable Ariane rockets.[31] When fully operational, ESA plans to compete directly with NASA's space shuttle for the business of launching nearly 200 commercial communications satellites to be placed in geostationary orbit in the 1980's.[32]

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ble External Tank, containing half a million gallons of propellants, secured to the Orbiter's belly; and, attached to the sides of the tank, a pair of reusable Solid Rocket Boosters, each longer and fatter than a railway tank car.

H. ALLAWAY, *supra* note 1, at 1; see STAFF OF HOUSE COMM. ON SCIENCE AND TECHNOLOGY, 96TH CONG., 2D SESS., SPACE SHUTTLE 1980 (Comm. Print 1980) for detailed discussion of the space shuttle program.

28. *See* H. ALLAWAY, *supra* note 1, at 4-6; Yardley, *A New Era of Space Transportation—Future Programs*, in A NEW ERA OF SPACE TRANSPORTATION—FUTURE PROGRAMS 7, 7-14 (L. Napolitano ed. 1977).

29. 14 C.F.R. § 1214.102 (1983) outlines the shuttle's pricing policy. It provides that the price will be held constant for flights in the first three years of shuttle operations. *Id.* § 1214.102(a)(3). Additionally, NASA offers a twenty percent discount on the standard flight price for shared-flight customers who agree to fly their payloads on a standby arrangement. *Id.* § 1214.102(c)(3). Special rates are also available for users who propose an experimental new use of space or a first-time use of great potential value to the public. *Id.* § 1214.102(b)(2)(vii). Finally, NASA will orbit small self-contained experiments as standbys for $3,000 to $10,000 (in 1975 dollars). *Id.* § 1214.102(d).

30. The members of the European Space Agency include the nations of Belgium, Denmark, France, the Federal Republic of Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. *See* Kaltenecker, *The European Space Agency (ESA)*, in 1 MANUAL ON SPACE LAW 427, 427 (N. Jasentuliyana & R. Lee eds. 1979).

31. *See* Gibson, *Overview of Current and Prospective European Space Programmes*, in ASTRONAUTICS FOR PEACE AND HUMAN PROGRESS 25, 31 (L. Napolitano ed. 1979). The European Space Agency completed its first successful commercial launch of its Ariane rocket on June 16, 1983, when it delivered two communications satellites into orbit. *See* L.A. TIMES, June 17, 1983, at 23, col. 5.

32. *See* Allnutt, *Space Phase 3: The Commercial Era Dawns*, AEROSPACE, Fall 1982, at 3, 6. Robert F. Allnutt is Acting Associate Administrator for External Affairs and

IV. Future Private Space Transportation Companies

A. Technological Advantages of Commercial Space Operations

The technological advantages of commercial operations in space will provide the economic incentives necessary for private industry to enter the space transportation business.[33] One aerospace company has identified 150 opportunities for profitmaking space industrialization.[34] The possibilities range from traditional projects such as telecommunications and remote earth sensing to innovative programs such as manufacturing new or improved products and producing energy in space for use on earth.

Telecommunications, the first and still the primary commercial use of space, will remain a major incentive for commercial space operations. Space communications have been useful for transmitting educational programs, establishing emergency communications in disaster areas, searching for lost aircraft and disabled ships, directing air traffic at sea, and, of course, providing quick and relatively inexpensive business and personal com-

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Deputy General Counsel for Policy Review at NASA. He thinks the shuttle will provide most of the satellite launches. *Id.* at 7. In an attempt to compete with the multipayload capability of the shuttle, ESA is developing a device to permit double launches. *See* Gibson, *supra* note 31, at 31. Despite the multipayload capability of the Ariane rocket, the cost of launching a small communications satellite in 1986 would be higher for the ESA launch than a shuttle launch. A NASA price analyst estimates that in 1982 dollars such a launch would cost $26 million for the shuttle and $32 million for the Ariane. *See* Waldrop, *Nasa Cuts Flights, Sets New Shuttle Price*, Science, July 2, 1982, at 35, 36.

For a discussion of the future of expendable launch vehicles in the age of the space shuttle, see d'Allest, *Ariane*, in Commercial Operations in Space: 1980-2000, at 153, 153-62 (1981).

33. Concerning the commercial era of space, NASA official Robert F. Allnutt commented:

> We stand today near the dawn of an era when commerce will become a far more significant factor among the three basic motivations for space programs in the western world. The other motivations—exploration and national defense—will remain strong, with the defense missions prime among these two. However, commercial enterprise, including but not at all limited to telecommunications, will surge to the forefront.

Allnutt, *supra* note 32, at 5.

For a discussion of the advantages of space technology used on earth, see J. Haggerty, Spinoff 1982, at 46-120 (1982), which mentions numerous applications of space technology on earth in areas such as transportation, consumer and recreational products, computer technology, health and medicine, industry productivity, environmental and public safety, commercial remote sensing, and technology demonstrations.

34. *See* H. Allaway, *supra* note 1, at 70; *see infra* notes 35-50 and accompanying text.

munications all around the world.[35] In the future, wrist telephones will be made possible by the construction of huge communications platforms in space serving hundreds of thousands of very small receivers on earth. Similar communications platforms in space will provide an electronic mail system on earth, allowing nearly instantaneous facsimile transmission of letters and other documents through satellites.[36]

Another traditional use of space has been the remote sensing of earth with satellites in space. Such satellites have been used to provide meteorological information, forecast agricultural crop production, survey natural resources, check for environmental problems, and map the entire earth.[37] With the earth's

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35. H. ALLAWAY, *supra* note 1, at 12. For a discussion of satellite communications in disaster situations, see Helm, *Disaster Communications Via Satellite*, in 2 USING SPACE—TODAY AND TOMORROW 49 (L. Napolitano ed. 1978). For a discussion of the new generation of communications satellites made possible by the advent of the space shuttle, see Braham, *Impact of Shuttle on Technology and Utility of National and Regional Communications Satellites*, in 2 USING SPACE—TODAY AND TOMMORROW 109 (L. Napolitano ed. 1978).

For discussion of the legal aspects of telecommunications, see generally Andhyarujina, *Direct Satellite Telecommunication and Space Law*, in PROCEEDINGS OF THE TWENTIETH COLLOQUIUM ON THE LAW OF OUTER SPACE 132 (M. Schwartz ed. 1978) (discussion of the legal problems and policies in direct satellite telecommunications); Goedhius, *Some Legal Aspects of the Use of Communications Satellites*, in PROCEEDINGS OF THE SEVENTEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 53 (M. Schwartz ed. 1975) (discussion of the historical development of global satellite communications systems and the applicability of international law to solving telecommunication legal problems); Hallgarten, *Legal Aspects of New Communications Satellite Services With Particular Reference to the Western Hemisphere*, in PROCEEDINGS OF THE TWENTIETH COLLOQUIUM OF THE LAW OF OUTER SPACE 251 (M. Schwartz ed. 1978) (discussion of telecommunications organizations in the Western Hemisphere and the application of national legislation and international law to these organizations).

36. *See* H. ALLAWAY, *supra* note 1, at 66.

37. *Id.* at 12-15; *see also* Mather & Coleman, *The Role of Geodetic Techniques in Remote Sensing the Surface Dynamics of the Oceans*, in 1 USING SPACE—TODAY AND TOMORROW 239 (L. Napolitano ed. 1978) (discussion of the refined techniques for monitoring the global ocean circulation for forecasting purposes); Paarlberg, *Crop Reporting from Space: Problems, Promises, Potential*, in COMMERCIAL OPERATIONS IN SPACE 1980-2000, at 111 (1981) (discussion of the usefulness of remote sensing techniques as a means of ohtaining information regarding the volume of crop production); Rouse, *New Developments in Microwave Remote Sensing*, in 1 USING SPACE—TODAY AND TOMORROW 259 (L. Napolitano ed. 1978) (discussion of microwave remote sensing for natural resources).

For discussion of the legal aspects of remote earth sensing, see generally Bordunov, *Legal Problems of International Cooperation in Remote Sensing*, in PROCEEDINGS OF THE TWENTY-SECOND COLLOQUIUM ON THE LAW OF OUTER SPACE 103 (1980) (discussion of the role of the United Nations in coordinating the international sharing of remote earth sensing date); Matte, *Remote Sensing by Satellites and Aerospace Law*, in PROCEEDINGS OF THE NINETEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 325 (M. Schwartz ed. 1977) (discussion of the role of national and international law in remote earth sensing).

natural resources becoming increasingly scarce, oil and mining companies are likely to provide increased demand for additional and improved remote sensing satellites.[38]

Materials processing in space is a new area providing a technological advantage for commercial space operations. Currently only a subject of experimentation,[39] in the future materials processing in space will result in the manufacture of new or improved products ranging from pharmaceuticals to high-strength permanent magnets. The production of materials in weightless space frees the process from gravitational forces that cause convection, sedimentation, bouyancy, and hydrostatic pressure.[40] The environment of space will allow weightless, containerless processing of extremely pure chemicals and metals for pharmaceuticals, superalloys, and superconductors.[41]

Another innovative area for commercial operations in space is energy production. Space provides an ideal location for pollution-free power plants that would be isolated from populated places and free from earthquake hazards. Additionally, the space environment allows easy disposal of excess heat, conservation of natural resources by lightweight construction,[42] and freedom from corrosion of materials. Also, energy storage and backup facilities will no longer be needed.[43] The three types of space power plants being studied are a satellite solar power station,[44] a

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38. *See* H. ALLAWAY, *supra* note 1, at 15.

39. *See, e.g.*, Avdujevsky, Grishin & Savitchev, *Technological Experiments on Board "Salyut-5,"* in 1 USING SPACE—TODAY AND TOMORROW 201 (L. Napolitano ed. 1978). The McDonnell Douglas Corporation has recently announced plans to build a device to manufacture in space a breakthrough drug that cannot be produced on earth. The weightless environment of space will facilitate the process necessary to make the drug. Initially, the factory will fly in the cargo bay of the space shuttle. Eventually, the company plans to orbit the device for six months or more, with shuttle crews bringing up raw materials and removing the finished products. *See* L.A. TIMES, May 24, 1983, at 1, col. 6.

40. *See* Zollner, *Materials Science and Engineering in Space*, in COMMERCIAL OPERATIONS IN SPACE: 1980-2000, at 19, 20-26 (1981).

41. *Id.* at 35.

42. Gerard K. O'Neill, noted Princeton University physicist, has suggested mining the moon for materials we need for production in space. G. O'NEILL, THE HIGH FRONTIER 143-44 (1977). Using lunar minerals to construct solar power plants would result in greater conservation of earth's resources.

43. *See* H. ALLAWAY, *supra* note 1, at 69.

44. The satellite solar power station would consist of immense arrays of photovoltaic cells (solar cells) placed in geostationary orbit where sunlight is always available. The solar cells would convert the sunlight into electricity which would, in turn, be converted into microwaves for transmission to earth. Once on earth the microwaves would he converted into electricity for use. *See* Glaser, *The Status of the Satellite Solar Power Station*, In FUTURE SPACE ACTIVITIES 81, 81-83 (C. Tross ed. 1976); Manson, *Satellite Power*

satellite solar thermal station,[45] and an orbiting nuclear reactor power plant.[46] Electricity from all three types of space power plants will be sent to earth in the form of microwaves that are reconverted into electricity upon arrival.[47] In light of dwindling earth resources and worldwide environmental problems, at least one commentator views the space power systems as potentially competitive economically.[48]

Large construction projects in space present a final area in which technological advantages provide the incentive for commercial operations in space. The other innovative uses of space discussed above necessitate these large construction projects in space. The weightlessness of space offers the advantage of con-

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Systems (SPS) Overview of System Studies and Critical Technology, in COMMERCIAL OPERATIONS IN SPACE: 1980-2000, at 95, 95 (1981).

45. The satellite solar thermal station would consist of large collectors of solar heat that would focus the sunlight on a central receiver, heating a gaseous working fluid to drive a turbogenerator. The electricity would be transmitted to earth as microwaves and reconverted into electricity for use. *See* H. ALLAWAY, *supra* note 1, at 69.

46. The orbiting nuclear power plant would contain fissionable material producing electricity by a turbogenerator. The electricity would be converted into microwaves for delivery to earth and reconverted into electricity for use. *See* Thom, Schneider & Helmick, *Gaseous-Fuel Nuclear Reaction Research for Multimegawatt Power in Space*, in 1 USING SPACE—TODAY AND TOMORROW 43, 43 (L. Napolitano ed. 1978).

For a discussion of the legal aspects of the use of nuclear power in space, see generally Galloway, *United Nations Consideration of Nuclear Power for Satellites*, in PROCEEDINGS OF THE TWENTY-SECOND COLLOQUIUM OF THE LAW OF OUTER SPACE 131 (1980) (discussion of the role of the United Nations in supervising the use of nuclear power in space); Gorbiel, *Some Comments on the Proposal Concerning Elaboration of New Legal Norms Governing Nuclear Power Sources in Outer Space*, in PROCEEDINGS OF THE TWENTY-THIRD COLLOQUIUM ON THE LAW OF OUTER SPACE 161 (1981) (discussion concerning international space law and nuclear power in space, concluding that special restrictions on the use of nuclear power in space are not presently needed).

47. *See* H. ALLAWAY, *supra* note 1, at 69; *see also* Gorove, *Legal Aspects of Solar Power Satellites: Focus on Microwave Exposure Standards*, in PROCEEDINGS OF THE TWENTY-SECOND COLLOQUIUM OF THE LAW OF OUTER SPACE 1 (1980) (discussion of the legal problems of microwave exposure from space power systems).

48. *See* Manson, *supra* note 44, at 95. For a discussion of the legal aspects of solar power satellites, see generally Diederiks-Verschoor, *Some More Observations on Solar Satellites and Their Legal Aspects*, in PROCEEDINGS OF THE TWENTY-THIRD COLLOQUIUM ON THE LAW OF OUTER SPACE 149 (1981) (discussion of international space law and the proposed solar power satellites); Moss, *Legal Considerations on the Development and Use of Satellite Solar Power Stations*, in PROCEEDINGS OF THE TWENTIETH COLLOQUIUM ON THE LAW OF OUTER SPACE 374 (M. Schwartz ed. 1978) (discussion of the application of international law to determine the status and ownership of space power stations and to solve the legal problems of microwave transmission); Rosenfield, *Solar Energy and the "Common Heritage of Mankind,"* in PROCEEDINGS OF THE TWENTY-FIRST COLLOQUIUM ON THE LAW OF OUTER SPACE 58 (M. Schwartz ed. 1979) (discussion concerning the effect of the international law doctrine of "The Common Heritage of Mankind" on the development of solar energy in space).

structing projects with lightweight beams of practically unlimited length.[49] Some have suggested the commercial feasibility of building huge colonies hovering in space between the earth and the moon.[50] Even if such colonies are technologically infeasible for several decades, large scale construction of other projects in space will help provide the economic incentives necessary for private industry to enter the space transportation business.

A number of commentators have questioned whether it is socially or economically prudent to invest in the industrialization of space when numerous problems remain to be solved on earth.[51] Some argue that it is socially and economically irresponsible even to consider industrial development in space in light of overpopulation, pollution, malnutrition, and nuclear proliferation.[52] Others assert that space industrialization is not now, and may never be, technologically feasible.[53] Supporters of space industrialization contend, on the other hand, that man's activity in space is in the best interest of the national economy.[54] Although it is beyond the scope of this Comment to weigh the socioeconomic costs and benefits of space industrialization, one must note that it will be extremely difficult to alleviate the social, political, and technological problems on earth with the money saved by foregoing space industrialization.[55] Moreover, the benefits of space industrialization will be felt on earth.[56]

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49. *See* Disher, *Planning for Large Construction Projects in Space*, in 1 USING SPACE—TODAY AND TOMORROW 79, 85 (L. Napolitano ed. 1978). In addition to fabrication in space, early space construction projects could rely on in-space assembly or deployment of modules constructed on earth. *Id.* at 81-84.

50. *See generally* G. O'NEILL, *supra* note 42 (discussion of space colonies, inhabited by 10,000 people, that could be constructed between the years 1990 and 2005). For a discussion of the legal nature of such colonies, see Glazer, *Domicile and Industry in Outer Space*, 17 COLUM. J. TRANSNAT'L L. 67 (1978).

51. *See, e.g.*, Bell, *Space—Is It Worth It?*, SPACE WORLD, Apr. 1981, at 17; Lapp, *$10 Billion More for Space?*, NEW REPUBLIC, Feb. 21, 1970, at 16; Yeliseyev, *Economic Efficiency of Space Flight*, SPACE WORLD, Oct. 1970, at 17.

52. *See, e.g.*, Lapp, *supra* note 51, at 19. Senator William Proxmire is a good example of those unwilling to spend funds on space industrialization. In response to the proposal to develop the space shuttle, Senator Proxmire commented in early 1970, "Spending billions to build the space shuttle-space station system isn't going to cure a sick child, provide a college education, build a house, feed a hungry family, or produce any tangible benefits here on Earth." *Id.*

53. *See, e.g*, Deudney, *Space Industrialization: The Mirage of Abundance*, THE FUTURIST, Dec. 1982, at 47.

54. *See, e.g.*, Yeliseyev, *supra* note 51, at 18.

55. *See, e.g.*, Bell, *supra* note 51, at 20, 25.

56. *See id.* at 20. A 1977 Denver Research Institute study of NASA's Technology Utilization Program, for example, concluded that for every dollar invested in the pro-

B. Other Incentives for Private Space Transportation Companies

In addition to the technological advantages of commercial operations in space, other factors provide incentives for privately operated space transportation companies. One incentive is the possibility of increased commercial activity in space through a governmental assistance program. The proposed Space Industrialization Acts of 1979[57] and 1980[58] called for the formation of a government corporation known as the Space Industrialization Corporation to promote, encourage, and assist in the development of new products, processes, and industries using the space environment. The Acts proposed to create a federal trust fund to provide a source of investment capital and to establish a government corporation that would administer the trust fund and enter joint ventures with private concerns. Ultimately, a stockholder-owned enterprise would replace the government corporation, and the federal appropriations would be returned to the United States treasury.[59] If something similar to the Space Industrialization Acts is enacted, the government assistance for commercial space operations should increase the need for transportation into space and provide an incentive for private enterprise to enter the space transportation business.

The government could provide additional incentives in the form of investment tax credits to encourage space industrialization. Tax credits currently provide incentives to rehabilitate older commercial buildings,[60] install energy conservation systems,[61] develop alternative renewable energy sources[62] such as solar,[63] wind,[64] and geothermal[65] energy, and hire new workers.[66]

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gram, there was a net gain in tangible benefits for the economy of six dollars, a benefit-to-cost ratio of six-to-one. *Id.*

57. H.R. 2337, 96th Cong., 1st Sess. (1979).

58. H.R. 7412, 96th Cong., 2nd Sess. (1980).

59. *See* Cassidy, *Space Industrialization Act and the Government Role in the Commercialization of Space*, in COMMERCIAL OPERATIONS IN SPACE: 1980-2000, at 119, 119-20 (1981).

60. I.R.C. § 48(g) (1982). *See* Lederman, *Renovations and Rehabilitations—Tax Aspects*, 39 INST. ON FED. TAX'N § 27 (1981).

61. I.R.C. § 44C(a)(1) (1982). *See* Suyderhoud & Strefeler, *Preferential Tax Treatment of Alternate Energy Sources and Energy Conservation*, 72 NAT'L TAX A. PROC. 275 (1979).

62. I.R.C. § 44C(a)(2) (1982). *See* Suyderhoud & Strefeler, *supra* note 61.

63. I.R.C. § 44C(c)(5)(A)(i) (1982); *see* Minan & Lawrence, *Encouraging Solar Energy Development Through Federal and California Tax Incentives*, 32 HASTINGS L.J. 1 (1980).

Additionally, special investment tax credits have been proposed to encourage domestic gasoline producers to increase supplies.[67] Since the government is using investment tax credits to stimulate private investment in certain industries, such tax credits could encourage the industrialization of space.[68]

The limitations of government-operated space transportation systems provide a major economic incentive for private space carriers. Fewer launches, higher launch prices, and government priority for military launches face commercial users of government-operated systems. In the United States, for example, budget cuts have reduced the number of shuttle flights over the next twelve years from 487 to 312.[69] Spreading the cost of the shuttle over fewer launches will nearly double the price commercial users pay.[70] Additionally, military use of the shuttle will significantly reduce the available commercial space on the remaining shuttle flights.[71] This reduced capacity of governmental transportation systems will provide additional incentives for private space transportation businesses.

A final incentive for private enterprise to enter the space transportation industry comes from the very nature of the agency operating the government system. NASA was formed in 1958 primarily as a research and development organization with no intention of becoming a launch service for commercial operations in space.[72] After just a few months of space shuttle operations, it is apparent that NASA wishes to be relieved of its responsibilities for operating the program.[73] The space agency

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64. I.R.C. § 44C(c)(5)(A)(ii) (1982).

65. *Id.* § 44C(c)(5)(A)(i).

66. *Id.* § 44B(a); *see* Barth, *The New Jobs Tax Credit*, 23 PRAC. LAW., Sept. 1, 1977, at 19; Merkelson, *The New Jobs Tax Credit: How Employers Can Maximize Benefits of its Provisions*, 47 J. TAX'N 66 (1977).

67. *See* Wunder, *Investment Tax Credit: Incentive to Stimulate Investment in Petroleum Industry*, 28 OIL & GAS TAX Q. 65 (1979).

68. The protechnology tax structure of the Federal Republic of Germany, for example, has provided incentive for private investment of $60 million in a private space transportation company. *See* Bennett, *Three, Two, One, Blastoff! Free Enterprise in Space*, SPACE WORLD, Dec. 1980, at 12, 14.

69. *See* Waldrop, *supra* note 32, at 35.

70. *Id.*

71. *See* Banks, *Overloaded Shuttle*, FORBES, July 19, 1982, at 33, 33-34.

72. *See* Good, *The Airlines in the 80's and 90's: What Would Juan Trippe Do?*, in COMMERCIAL OPERATIONS IN SPACE: 1980-2000, at 123 (1981).

73. When informed of a successful test launch of a private rocket company, one unidentified NASA official commented, "We're happy as hell. We want out of the launch business." *Outer-Space Enterpreneurs*, TIME, Sept. 20, 1982, at 19, 19.

plans to transfer the marketing operations of the shuttle program to either a private company[74] or a new United States Space Transportation Corporation by 1985.[75] NASA hopes to transfer the entire operational shuttle responsibility by 1986 or 1987.[76] Thus, even without the entry of new private launch companies, space shuttle launches within the next few years will likely become the function of private enterprise rather than of a governmental agency.

C. Potential Space Transportation Companies

1. Boeing and other aerospace companies

As early as 1978 NASA officials admitted that the Boeing Company, a major aerospace firm, had expressed an interest in becoming the private owner-operator of the United States space shuttle system.[77] Boeing officials have confirmed reports that the company plans to study the potential profitability of private ownership and operation of the shuttle system. The company has also investigated how a transition could be made from government to private manned flight operations and the type of congressional legislation or presidential directive necessary to transfer the complete shuttle operation to the commercial sector. Under the Boeing plan conversion to a private manned space flight launch service could be complete in about seven years.[78] The purchase of the United States space shuttle system by Boeing or some other aerospace firm would instantly create

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74. *See* Covault, *NASA Planning for Shift of Shuttle Marketing Operations*, AVIATION WEEK & SPACE TECH., Nov. 1, 1982, at 16. The proposed marketing arrangements offer the advantages of innovative financing, reinvestment of profits, dedicated marketing personnel paid on an incentive basis, and field offices for greater access to international space launch traffic. *Id.* at 16-18.

75. Under a United States Space Transportation Corporation a government corporation would contract to launch all commercial and foreign payloads while NASA would launch all payloads for the United States Government itself. The new government corporation would market launches at the most competitive price and pay NASA for its launch services at its most inexpensive cost. *Id.* at 16.

76. *Id.* Boeing and other aerospace manufacturers are considering taking over complate operations of the shuttle systems. *See* Covault, *Boeing Eyes Private Shuttle Operation*, AVIATION WEEK & SPACE TECH., Oct. 2, 1978, at 23, 23; Good, *supra* note 72, at 124.

77. *See* Covault, *supra* note 76, at 23. "NASA senior management is generally in favor of concepts like Boeing's because they free NASA personnel for what the agency wants to remain—a research and development agency without too much operational system responsibility." *Id.*

78. *Id.*

the nation's first fully operational private space transportation company, responsible for deploying satellites, conducting experiments, and carrying scientists into space.

2. *Space Transportation Company*

One of the most ambitious of the new generation of private space transportation firms is Space Transportation Company (SpaceTran) of Princeton, New Jersey. Promoted by a group of eight investment bankers and venture capitalists,[79] the company has entered serious negotiations with high level NASA officials concerning its proposal to finance a fifth shuttle orbiter (a victim of budget cuts) for the space agency. The firm plans to raise privately the one billion dollars and purchase the shuttle from Rockwell International, with delivery to be made in 1986.[80] SpaceTran would retain ownership of the fifth orbiter but allow NASA to integrate the ship within its fleet and operate the shuttle as one of its own. NASA, in return, would provide SpaceTran with the exclusive rights to sell commercial cargo space on the entire shuttle fleet.[81]

In addition to the orbiter project, SpaceTran has signed an agreement with Martin Marietta to market and launch the Titan 34D booster commercially from Cape Canaveral, Florida. The agreement provides for the purchase of four expendable rocket boosters allowing private launches by 1985. SpaceTran has indicated it will go forward with the expendable rocket launches regardless of whether it is able to purchase the fifth shuttle orbiter.[82]

3. *Space Services, Inc.*

The one private American space transportation company that has already managed to launch a rocket is Space Services, Inc. of America (SSI). On September 9, 1982, SSI launched

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79. Prudential Insurance Company has agreed to take up to a 40% equity stake in the company, whose capitalization has not been settled. *See* Banks, *supra* note 71, at 34.

80. *See* Waldrop, *Firm Offers to Finance a Space Shuttle*, 215 SCIENCE 879 (1982). In an unrelated move, Citicorp, the banking and investment company, has expressed an interest in privately financing a fifth space shuttle orbiter that it would lease back to NASA. *See Citicorp Shows Interest in Financing Orbiter*, AVIATION WEEK & SPACE TECH., Nov. 1, 1982, at 16.

81. *See Private Space Shuttle*, SCI. DIG., June 1982, at 18.

82. *See Space Transportation Firm Agrees to Marketing of Titan*, AVIATION WEEK & SPACE TECH., Dec. 6, 1982, at 6-27.

America's first private commercial rocket into space in a ten and a half minute suborbital flight that reached an altitude of 192 miles and landed in the ocean over 320 miles downrange of the Matagorda Island, Texas, launching pad. The company plans to sell its launch services to oil firms and other corporations that want to put up low-orbit communications and remote earth-sensing satellites. The first satellite launch is planned for late 1984 or early 1985,[83] and monthly flights are to begin within four years.[84] SSI is also investigating using current, expendable NASA vehicles in their operations. Additionally, the firm plans to construct a Hawaiian launch pad by 1986.[85] The Texas real estate investors financing SSI are looking for a profit by at least 1985.[86]

4. Others

Outside the United States one of the better known private space transportation firms is Orbital Transport and Raketen A.G. (Otrag), a West German company that has been promoting its system of low cost rockets since the early 1970's. Otrag plans to launch commercial satellites into orbit from a Zaire, Africa, site using expendable rocket modules clustered together into boosters. The firm has strong support from West German investors who have capitalized the company in excess of sixty million dollars.[87]

Two other American companies that will possibly enter the space transportation business are Project Private Enterprise, Inc. (PPE) and Advanced Propulsion Technology (APT). PPE was formed several years ago to carry goods and perhaps passengers into space on reusable ships. Although the company conducted successful stationary test firings of its launch vehicle in 1980, it has yet to launch a rocket into space. APT is a research and development company formed to develop innovative space propulsion systems.[88]

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83. *See* Chartrand, *On The New Conestoga Trail—A Personal Account*, SPACE WORLD, Nov. 1982, at 4.

84. *See Free Enterprise Goes into Space*, U.S. NEWS & WORLD REP., Sept. 20, 1982, at 12.

85. *See Outer-Space Entrepreneurs*, *supra* note 73, at 19.

86. *See* David, *SSI: Heading for Entrepreneurial Orbits*, SPACE WORLD, Aug./Sept. 1982, at 20.

87. *See* Bennett, *supra* note 68, at 13-14.

88. *Id.*

V. Liability of a Privately Operated Space Carrier to its Customers

A. *Possibility of Injury to a Customer*

The promising prospects for private space transportation systems require the investigation of the liability such private carriers may incur to their customers in the transportation of goods into space. The activities of a privately operated space carrier may injure its customer in several ways. The most severe injury that a customer can suffer is failure to place the goods in orbit, resulting in their total destruction in space or on the ground.[89] Another serious injury to a customer is placement of the goods in an improper orbit, such as a failure to attain geostationary orbit. A February 1984 mission of the space shuttle Challenger illustrates such an injury to customers of space transportation systems. During that mission the two satellites deployed by the shuttle failed to attain proper geostationary orbits because the payload assist modules, which launch the satellites into the higher orbit, misfired. Although NASA officials have stated that the Challenger functioned properly during the unsuccessful launches, the result remains the same—the loss of two $75 million communications satellites.[90] Unreasonable delay of a launch can also harm a customer of a space transportation service.

B. *Tort Liability of a Privately Operated Space Carrier*

1. *Space carriage—an abnormally dangerous activity?*

The law has not resolved whether the liability of space carriers to their customers should be based upon fault (i.e., a negligence standard) or upon strict liability. An examination of the

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89. There are numerous incidents of payloads being destroyed in an attempt to place them in orbit. For example, during the first three years of the United States space program rocket malfunction destroyed 28 satellite payloads before they achieved orbit. Legal Problems of Space Exploration: A Symposium, S. Doc. No. 26, 87th Cong., 1st Sess. 1306-27 (1961). Failure to achieve orbit has continued to be a problem even after the early experimental years of space exploration. In the late 1970's a Thor Delta launcher failed to place into orbit a European Space Agency telecommunications satellite, OTS. *See* Gibson, *supra* note 31, at 27.

90. *See* Begley, *One High and a Lot of Lows*, Newsweek, February 20, 1984, at 55, 56.

The European Space Agency's first geostationary satellite, GEOS, failed to achieve its proper orbit because of a malfunction of the Thor Delta launcher. *See* Gibson, *supra* note 31, at 25.

development and limitations of the doctrine of strict liability for abnormally dangerous activities will aid in deciding the basis of liability that should be used for determining the duty a space carrier owes to his customers. Because this issue is analogous to the liability questions that faced the air transportation industry during its infancy, the liability standard in the early years of air travel is helpful in resolving the liability of space carriers to their customers. Additionally, analysis of international agreements, such as the Convention on International Liability for Damage Caused by Space Objects,[91] will help in determining the current attitude towards liability for space carriers to their customers.

a. The doctrine of Rylands v. Fletcher. The doctrine of strict liability for abnormally dangerous activities traces its development in the United States from the English case of *Rylands v. Fletcher*,[92] which was decided by the House of Lords in 1868. In *Rylands* the defendants, owners of a mill in an area primarily used for coal mining, constructed a reservoir upon their land. When the reservoir was partially filled the water broke through an abandoned, earth-filled shaft of a coal mine, and flooded along connecting passages into an adjoining mine of the plaintiff.[93] In affirming the decision of the Court of Exchequer, the House of Lords ruled that a defendant could be held strictly liable if he devotes his land to a "non-natural" use and thereby causes damage to neighboring property.[94] Subsequent British decisions have confined the *Rylands* doctrine of strict liability to things or activities that are extraordinary, exceptional, or abnormal.[95]

Although they initially rejected the *Rylands* decision, most American jurisdictions now follow a doctrine similar to *Rylands v. Fletcher* imposing strict liability for an abnormally dangerous condition or activity that is not a natural one in its location.[96] The first *Restatement of Torts* adopted the principle of *Rylands*

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91. Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, T.I.A.S. No. 7762 (hereinafter cited as Liability Convention).

92. 3 L.R.-E. & I. App. 330 (H.L. 1868).

93. *Id.* at 337-38.

94. *Id.* at 340.

95. *See* W. PROSSER, HANDBOOK OF THE LAW OF TORTS § 78, at 506 (4th ed. 1971).

96. *Id.* at 509-12; *see also* Comment, *The Rylands v. Fletcher Doctrine in America: Abnormally Dangerous, Ultrahazardous, or Absolute Nuisance?*, 1978 ARIZ. ST. L.J. 99 (extensive discussion of the application of *Rylands* in the United States).

v. Fletcher in 1938.[97] Section 519 of the first *Restatement* imposed strict liability upon a party for the miscarriage of an ultrahazardous activity.[98] An ultrahazardous activity is one that "necessarily involves a risk of serious harm to the person, land, or chattels of others that cannot be eliminated by the exercise of the utmost care" and that "is not a matter of common usage."[99]

The *Restatement (Second) of Torts* in 1977 reaffirmed the *Rylands* doctrine of strict liability.[100] The second *Restatement* eliminates the term "ultrahazardous" in favor of "abnormally dangerous." This later version also limits the imposition of strict liability "to the kind of harm, the possibility of which makes the activity abnormally dangerous."[101] The *Restatement (Second)* lists six factors to be analyzed in determining whether an activity is abnormally dangerous: the high degree of risk, the likelihood of great harm, the inability to eliminate the risk, the extent to which the activity is not a matter of common usage, the inappropriateness of the activity to its location, and the value of the activity to the community.[102] These factors closely parallel the common-law rule of strict liability for abnormally dangerous activities.[103] Thus, jurisdictions in the United States have imposed strict liability for abnormally dangerous activities when a high degree of risk of harm existed,[104] the risk could not have been eliminated with reasonable care,[105] the activity was not a matter of common usage,[106] or the activity was carried on in an unusual place.[107] Therefore, one must examine these factors and circumstances to determine whether the carriage of goods into space should be regarded as an abnormally dangerous activity.

b. Space carriage and the doctrine of Rylands v. Fletcher. Although no American court has analyzed whether carriage of goods into space is an abnormally dangerous activity, three cases

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97. RESTATEMENT OF TORTS §§ 519-520 (1938).

98. *Id.* § 519.

99. *Id.* § 520.

100. RESTATEMENT (SECOND) OF TORTS §§ 519-520 (1977).

101. *Id.* § 519.

102. *Id.* § 520.

103. *See* W. PROSSER, *supra* note 95, at 508-12.

104. *See, e.g.*, Luthringer v. Moore, 31 Cal. 2d 489, 190 P.2d 1 (1948) (fumigation of part of a building with hydrocyanic acid gas).

105. *See, e.g.*, Exner v. Sherman Power Const. Co., 54 F.2d 510 (2d Cir. 1931) (use of explosives).

106. *See, e.g.*, Colton v. Underdonk, 69 Cal. 155, 10 P. 395 (1886) (blasting).

107. *See, e.g.*, Green v. General Petroleum Corp., 205 Cal. 328, 270 P. 952 (1928) (drilling for oil in a residential community).

have determined that rockets can be abnormally dangerous under the doctrine of *Rylands v. Fletcher.* The first of these cases, *Berg v. Reaction Motors Division,*[108] concerned ground tests in 1958 and 1959 of the rocket engine for the X-15 supersonic airplane. The tests were conducted 3,500 feet and 6,800 feet from the center of the village of Lake Telemark, New Jersey. Residents of the town brought suit alleging that the rocket engine tests caused them personal discomfort and structurally damaged their homes.[109] Comparing the rocket motor tests of the defendant to the introduction of blasting in a community, the court concluded that the defendant's activities were ultrahazardous. Thus, reasoning that the cost of any damage should be absorbed as an operating business expense of the enterprise, the court held the defendant strictly liable for the damage caused in the neighboring community.[110]

Smith v. Lockheed Propulsion Co.,[111] the second of these rocket cases, involved a 1962 test firing of a 120-inch, solid-fuel, applied research rocket motor. The test occurred approximately 7,800 feet from the boundary of the plaintiff's ranch. The plaintiff brought suit when seismic vibrations from the test damaged his water-well beyond repair.[112] In deciding whether the defendant's activity was ultrahazardous, the court noted that the rocket motor was the largest ever tested to that date. It also commented that test firing such a device was not a matter of common occurrence.[113] Additionally, the court recognized that although the test site was in a generally undeveloped area, the defendant should have been fully cognizant of the risk of harm to the plaintiff's lands and improvements since portions of the defendant's property bordered the plaintiff's ranch on three sides.[114] Citing *Berg* and the first *Restatement of Torts,* the court concluded that the rocket test was an ultrahazardous activity for which the defendant should be held strictly liable.[115]

The third case discussing the standard of liability for rockets was *H.L. Properties, Inc. v. Aerojet-General Corp.,*[116] which

108. 37 N.J. 396, 181 A.2d 487 (1962).
109. *Id.* at 399-404, 181 A.2d at 488-91.
110. *Id.* at 410, 181 A.2d at 494.
111. 247 Cal. App. 2d 774, 56 Cal. Rptr. 128 (1967).
112. *Id.* at 778, 56 Cal. Rptr. at 132-33.
113. *Id.* at 785, 56 Cal. Rptr. at 137.
114. *Id.* at 787, 56 Cal. Rptr. at 138.
115. *Id.* at 785-86, 56 Cal. Rptr. at 137-38.
116. 331 F. Supp. 1006 (S.D. Fla. 1971).

concerned a 1967 test of a 260-inch, solid-fuel rocket motor. The rocket motor emitted into the atmosphere hydrogen chloride gas, which mixed with rain or moisture, thus forming hydrochloric acid. The acid rain fell on the plaintiff's land damaging fruit crops and plants.[117] The parties stipulated that the rocket test was an ultrahazardous activity, and the defendant conceded that it was negligent.[118]

In a fourth rocket motor testing case the court applied a negligence standard rather than imposing strict liability. In *Pigott v. Boeing Co.*[119] the plaintiffs alleged that concussions and vibrations from the test of a Saturn Booster Rocket damaged their home in Hancock County, Mississippi.[120] Even though Mississippi had adopted the doctrine of strict liability for damages caused by vibrations and concussions from blasting,[121] the court applied a negligence standard to determine whether the defendant should be held liable for the damages caused by the rocket test.[122] Although the court's brief opinion did not indicate why it required a showing of negligence rather than imposing strict liability, the court noted that the defendant had conducted the rocket firing at a special NASA test site consisting of a large area of land acquired in fee by NASA. The court also pointed out that NASA had easements on an additional buffer zone area.[123] The plaintiff's house was located outside the buffer zone.[124] Additionally, the court recognized that Congress had declared NASA's research necessary for the general welfare and security of the United States.[125] The court concluded that the complaint did not allege any fact constituting negligence.[126]

In determining whether space carriers should be strictly liable to their customers, one must note several differences between the static rocket motor firing tests of the late 1950's to

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117. *Id.* at 1007-08. The parties stipulated that the rocket firing had caused the acid rain that damaged the plaintiff's fruits and plants. For a discussion of causation and acid rain where there is no stipulation, see Comment, *Causation in Acid Rain Litigation: Facilitating Proof with Joint Liability Theories*, 1983 B.Y.U. L. REV. 657.

118. 331 F. Supp. at 1008.

119. 240 So. 2d 63 (Miss. 1970).

120. *Id.* at 63.

121. *See* Teledyne Exploration Co. v. Dickerson, 253 So. 2d 817, 818-19 (Miss. 1971); Central Exploration Co. v. Gray, 219 Miss. 757, 765-66, 70 So. 2d 33, 37 (1954).

122. 240 So. 2d at 64.

123. *Id.* at 63.

124. *Id.* at 64.

125. *Id.* at 63.

126. *Id.* at 64.

mid 1960's, and the era of private space carriers in the mid to late 1980's. During the 1950's and 1960's the novelty of space travel and rocket use was one factor leading to an abnormally dangerous classification.[127] A high degree of risk of harm and the inability to eliminate such risks with the available technological knowledge were other factors making those early tests and launches abnormally dangerous.[128] Additionally, the unusualness of rocket testing in a residential community was a factor leading to the classification of such tests as abnormally dangerous.[129] In comparison, a negligence standard, rather than strict liability, was applied when the rocket test took place on a remote NASA test sight surrounded by a buffer zone.[130]

The private carriage of goods into space in the 1980's will lack many of the abnormally dangerous factors present in the early years of space travel. With the advent of the space shuttle the carriage of goods into space has become more common. Space carriage will become increasingly more frequent as commercial operations in space develop. Therefore, space transportation will become more a matter of common usage and will less likely be viewed as an abnormally dangerous activity.[131] Space carriage is also less likely to be considered ultrahazardous because the high degree of risk has been reduced by redundant backup systems.[132] Additionally, rocket launches are conducted at isolated launch facilities rather than residential areas.[133] Therefore, it is arguable that the carriage of goods into space may not be an abnormally dangerous activity.

Economic analysis may also enter into a decision whether a space transportation company should be strictly liable to its cus-

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127. *See, e.g.*, Smith, v. Lockheed Propulsion Co., 247 Cal. App. 2d 774, 785, 56 Cal. Rptr. 128, 137 (1967). *See* RESTATEMENT (SECOND) OF TORTS § 520(d) (1977).

128. *See, e.g.*, Berg v. Reaction Motor Div., 37 N.J. 396, 410, 181 A.2d 487, 494 (1962). *See* RESTATEMENT (SECOND) OF TORTS § 520(a), (c).

129. *See, e.g.*, Berg v. Reaction Motor Div., 37 N.J. 396, 410, 181 A.2d 487, 494 (1962). *See* RESTATEMENT (SECOND) OF TORTS § 520(e).

130. *See, e.g.*, Pigott v. Boeing Co., 240 So. 2d 63 (Miss. 1970).

131. *See supra* text accompanying note 25.

132. The United States space shuttle, for example, has five computers on board. Four of the computers process the same data simultaneously so that in a disagreement the computers vote, and commands from an outvoted computer are ignored. The fifth computer operates completely as a backup system. *See* H. ALLAWAY, *supra* note 1, at 53. Although private space carriers may not be able to afford as much redundancy as the shuttle, private space vehicles will undoubtedly contain numerous backup systems to reduce the degree of risk.

133. Space Service, Inc., for example, launched their first rocket from a remote island off the coast of Texas. *See* Chartrand, *supra* note 83, at 4.

tomers for damage to the goods being carried. Indeed, several commentators have argued that the economic aspect of tort liability should be the primary factor in determining the standard to which the law should hold the defendant.[134] Under economic analysis, imposing strict liability on defendants engaged in an abnormally dangerous activity provides greater incentive for research and development of new safety devices because the defendant must bear the costs of all accidents.[135] Additionally, strict liability enables the cost of an unavoidable accident, which under a negligence standard would be placed upon the victim, to be spread among the customers or shareholders of the enterprise as a cost of doing business.[136] Commentators have also argued that strict liability results in a more efficient judicial system.[137] Thus, the commentators conclude that strict liability for abnormally dangerous activities has been imposed in "cases where the potential victims of the injury are not in a good position to make adjustments that might in the long run reduce or eliminate the risk of injury."[138]

In the field of space transportation the customers will be able to reduce the risk of loss by purchasing insurance from the space insurance industry. Users of current space transportation systems already use insurance to reduce their risk of loss.[139] Therefore, economic analysis of tort liability does not require one to hold a space carrier strictly liable to its customers for damage to the goods being carried.

Although many commentators argue that space vehicles should be held strictly liable for damage that occurs to third parties on the earth's surface or in the air,[140] the conclusion does

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134. *See, e.g.*, R. POSNER, ECONOMIC ANALYSIS OF LAW (2d ed. 1977); Calabresi, *Some Thoughts on Risk Distribution and the Law of Torts*, 70 YALE L.J. 499 (1961); Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960); Ehrlich & Posner, *An Economic Analysis of Legal Rulemaking*, 3 J. LEGAL STUD. 257 (1974); Rizzo, *Law Amid Flux: The Economics of Negligence and Strict Liability in Tort*, 9 J. LEGAL STUD. 291 (1980). *But see* Steiner, *Economics, Morality, and the Law of Torts*, 26 U. TORONTO L.J. 227 (1976).

135. *See* R. POSNER, *supra* note 134, § 6.11, at 138.

136. *See id.* at 141.

137. *See* Rizzo, *supra* note 134, at 317.

138. R. POSNER, *supra* note 134, § 6.11, at 140-41.

139. *See infra* notes 178-179 and accompanying text.

140. *See, e.g.*, M. MCDOUGAL, H. LASSWELL & I. VLASIC, LAW AND PUBLIC ORDER IN SPACE 615-16 (1963); Cooper, *Memorandum of Suggestions for an International Convention on Third Party Damage by Space Vehicles*, in THIRD COLLOQUIUM ON THE LAW OF OUTER SPACE 141 (A. Haley & K. Gronfors eds. 1960); Mazaroff, *Exonerations from Liability for Damage Caused by Space Activities*, 54 CORNELL L. REV. 71, 74-75 (1968).

not necessarily follow that space carriers should be strictly liable for damage to their customers' goods. The doctrine of strict liability should be limited to the kind of injury, the possible occurrence of which makes the activity abnormally dangerous.[141] For space carriers, the presence of highly explosive fuel in a rocket travelling at great speeds may make the vehicle abnormally dangerous to persons or things on the ground or in the air. Nevertheless, a rocket should not be considered ahnormally dangerous to its cargo which cannot reach its intended destination without such explosive fuels and great speeds.[142] Therefore, the possibility of harm to third parties on the ground or in the air is not a factor that calls for the extension of the doctrine of strict liability to the duty a space carrier owes to his customers.

c. *Analogy of strict liability for aircraft.* The issue of strict liability for space carriers is analogous to the liability questions that faced the air transportation industry during its infancy. In the early years of air travel the courts considered flight an abnormally dangerous activity and held operators of aircraft strictly liable for the harm they caused. The earliest case in the United States applied the strict accountability rule upon the theory that a hot air balloon was a dangerous instrumentality, comparable to a wild beast, fire, and explosives.[143] When techno-

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141. RESTATEMENT (SECOND) OF TORTS § 519(2) (1977).

142. The doctrine of voluntary assumption of risk may also enter into a determination of the liability of a space carrier to his customer. Under the assumed risk doctrine a defendant may be relieved of his liability to a plaintiff in negligence or strict liability if the plaintiff knows and understands the risk that he freely and voluntarily incurs. *See* W. PROSSER, *supra* note 95, § 68, at 447 and § 79, at 523; *see also* Bohlen, *Voluntary Assumption of Risk*, 20 HARV. L. REV. 14, 16-18, 91 (1906) (leading article on the assumption of risk doctrine, discussing the origin of the doctrine and its application). One could argue under the assumption of risk doctrine that a space carrier should not be liable to a plaintiff shipping goods into space since the plaintiff was fully aware of the inherent dangers of space carriage and voluntarily assumed the risk of such dangers when he decided to ship his goods into space. There has been considerable debate, however, on whether the doctrine of assumption of risk constitutes a separate defense. *Compare* RESTATEMENT (SECOND) OF TORTS §§ 496A-496G (1965) (stating that implied assumption of risk should be recognized as a separate defense) *with* Green, *Assumed Risk as a Defense*, 22 LA. L. REV. 77 (1961) *and* James, *Assumption of Risk: Unhappy Reincarnation*, 78 YALE L.J. 185 (1968) (articles critical of the assumption of risk doctrine as a defense). Moreover, many jurisdictions have abolished or severely limited the doctrine. *See, e.g.*, Fawcett v. Irby, 92 Idaho 48, 436 P.2d 714 (1968), discussed in Note, *Assumption of Risk Bites the Dust in Idaho—Almost*, 6 IDAHO L. REV. 119 (1969). Thus, it is uncertain whether the assumption of risk doctrine would be available as a defense against the liability of a space carrier to its customers.

143. Guille v. Swan, 19 Johns. 381 (N.Y. 1822). The court held Guille strictly liable for the damage his balloon caused when it landed in Swan's garden in New York City,

logical advances led to the development of motorized flights, the doctrine of strict liability was applied to the early airplanes.[144]

The first *Restatement of Torts* agreed that operators of aircraft should be held strictly liable for injury or damage. According to the *Restatement,* aviation was "ultrahazardous because even the best constructed and maintained aeroplane is so incapable of complete control that flying creates a risk that the plane, even though carefully constructed, maintained, and operated, may crash to the injury of persons, structures, and chattels on the land over which the flight is made."[145] The *Restatement (Second) of Torts* continues to hold the operator of an aircraft strictly liable for ground damage[146] even though considerable authority to the contrary exists.[147]

The National Conference of Commissioners on Uniform State Laws also agreed that strict liability should be imposed upon aircraft. In 1922 the Conference approved the Uniform Aeronautics Act[148] to provide guidance to the states concerning the regulation of aircraft. The Act, which was adopted by twenty-four states,[149] imposed absolute liability upon aircraft owners and lessees for injuries to persons or property on the ground.[150] The Conference continued to support strict liability

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partially destroying a crop of potatoes and radishes. *Id.* at 381-83.

144. *See, e.g.,* Rochester Gas & Elec. Corp. v. Dunlop, 148 Misc. 849, 266 N.Y.S. 469 (N.Y. Civ. Ct. 1933).

145. RESTATEMENT OF TORTS § 520 comment b (1938).

146. RESTATEMENT (SECOND) OF TORTS § 520A (1977). The section states:

> If physical harm to land or to persons or chattels on the ground is caused by the ascent, descent or flight of aircraft, or by the dropping or falling of an object from the aircraft,
>
> (a) the operator of the aircraft is subject to liability for the harm, even though he has exercised the utmost care to prevent it, and
>
> (b) the owner of the aircraft is subject to similar liability if he has authorized or permitted the operation.

Id.

147. *See, e.g.,* Boyd v. White, 128 Cal. App. 2d 641, 651, 276 P.2d 92, 99-100 (1954) (expressing the general view that an airplane is not an inherently dangerous instrument when properly handled by a competent pilot); Cooper, *Aircraft Liability to Persons and Property on Ground,* 17 A.B.A. J. 435 (1931); *Report of the Standing Committee on Aeronautical Law of the American Bar Association, September, 1931,* 2 J. AIR L. & COM. 545 (1931).

148. Unif. Aeronautics Act (act withdrawn 1943), 1922 HANDBOOK NAT'L CONF. COMMISSIONERS UNIFORM STATE L. 105-06.

149. *See* Prentiss v. National Air Lines, Inc., 112 F. Supp. 306, 308 (D.N.J. 1953).

150. Unif. Aeronautics Act § 5. The liability section reads in pertinent part:

> The owner of every aircraft which is operated over the lands or waters of this State is absolutely liable for injuries to persons or property on the land or water beneath, caused by the ascent, descent or flight of the aircraft, or the

in a 1938 draft of the proposed Uniform Aviation Liability Act.[151]

Despite their strong initial support, the proponents of strict liability for aircraft limited the doctrine to accidents involving harm to persons or property on the ground. Both the *Restatement* and *Restatement (Second) of Torts* specifically limit strict liability for abnormally dangerous activity to ground injuries.[152] Similarly, the Uniform Aeronautics Act did not impose absolute liability upon an aircraft operator for injuries to passengers or goods on the aircraft.[153] Additionally, the proposed Uniform Aviation Liability Act specifically exempted injuries to passengers, baggage, or goods from the scope of the Act.[154] Therefore, even

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> dropping or falling of any object therefrom, whether such owner was negligent or not, unless the injury is caused in whole or in part by the negligence of the person injured, or of the owner or bailee of the property injured. If the aircraft is leased at the time of the injury to person or property, both owner and lessee shall be liable, and they may be sued jointly, or either or both of them may be sued separately.

1922 HANDBOOK NAT'L CONF. COMMISSIONERS UNIFORM ST. L. 324 (footnotes omitted).

151. Unif. Aviation Liability Act (approved in 1938 but withheld for further consideration by the Conference), 1938 HANDBOOK NAT'L CONF. COMMISSIONERS UNIFORM STATE L. 166-70. Proposed § 202 would have imposed absolute liability on the operator of an aircraft:

> In cases within the scope of this article, the operator of an aircraft shall be liable, in an action brought within this Stete as in this article specified, regardless of negligence, for bodily injury to an individual and for death resulting therefrom and damage to property, to the extent in this article specified.

Id. at 322.

152. *See* RESTATEMENT OF TORTS § 520 comment b (1938) (referring to "injury of persons, structures and chattels on the land over which the flight is made"). RESTATEMENT (SECOND) OF TORTS § 520A comment e (1977) states:

> An operator or owner of an aircraft is subject to strict liability under this Section only for physical harm to land, or to persons or chattels on the ground. He is not subject to liability under this Section to persons themselves participating in aviation, such as the crew or passengers of a falling plane, or the owner of property on it or to persons on another plane which was struck by the defendant's plane. Different tort rules govern his liabilities to them.

Id.

153. *See, e.g., Prentiss*, 112 F. Supp. 306, 310.

154. Section 201 would have limited the scope of absolute liability to ground injury or damage:

> (a) This article shall apply to liability for bodily injuries within this State and for death resulting therefrom to individuals on the land, and for damage within this Stete to property on the land, caused by the ascent or descent or attempt to ascend, or flight of an aircraft, or by the falling of an object therefrom;
>
> (b) This article shall not apply to liability for bodily injuries to or death of passengers or of employes [sic] entitled to workmen's compensation of the operator of the aircraft, or for loss of or damage to baggage, personal effects or

though airplane operators were subject to strict liability in the early years of air travel, strict liability was not imposed upon the operator for harm to passengers or goods on the aircraft. Thus, the rejection of strict liability for injury to air passengers and goods supports the conclusion that strict liability should not be imposed upon space carriers for the damage they cause to the goods they carry.

d. Analogy of international liability for space vehicles. The conclusion that a space carrier may be held to strict liability for certain mishaps and a negligence standard for others is supported by the Convention on International Liability for Damage Caused by Space Objects.[155] As an international agreement establishing the liability of nations for damage caused by their space objects, the Liability Convention does not directly define the liability of *private* space carriers to their customers. Nevertheless, the agreement is useful in assessing the basis of liability that should be imposed on private carriers for damage to their customers' goods.

The Liability Convention holds a launching state[156] strictly liable for damage caused by its space objects[157] on the surface of the earth or to aircraft in flight.[158] For accidents occurring in space and for injury to persons or property on board a space vehicle, however, the Convention has established a negligence standard of liability.[159] The Liability Convention states:

> In the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object hy a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for

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goods on the aircraft at the time of or immediately prior to the accident. Unif. Aviation Liability Act § 201, 1938 HANDBOOK NAT'L CONF. COMMISSIONERS UNIFORM STATE L. 322.

155. Liability Convention, *supra* note 91. *See generally,* Cheng, *Convention on International Liability for Damage Caused by Space Objects,* in 1 MANUAL ON SPACE LAW 83 (N. Jasentuliyana & R. Lee eds. 1979) (thorough discussion of the provisions of the Liability Convention).

156. The term "launching state" is defined as both the "State which launches or procures the launching of a space object" and the "State from whose territory or facility a space object is launched." Liability Convention, *supra* note 91, art. I(c).

157. "The term 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof." *Id.* art. I(d).

158. *Id.* art. II.

159. *Id.* art. III.

> whom it is responsible.[160]

The members of the Convention supported the negligence standard for an object in space in part because the possibility of damage in space was extremely unlikely.[161] The two tier standard of liability established by the Liability Convention supports the conclusion that negligence is the proper basis of liability for damage caused by a space carrier to his customers' goods.

2. Common carrier versus private carrier

Even though the carriage of goods into space may not be an abnormally dangerous activity, space transportation companies may nonetheless be subject to a standard of care higher than that for ordinary negligence if they are considered common carriers.[162] A common carrier has been defined as "one who, by virtue of his calling, undertakes, for compensation, to transport personal property from one place to another for all who may choose to employ him, and everyone who undertakes to carry for compensation all persons indifferently, is, as to liability, to he deemed a common carrier."[163] Because it is held to a standard of care higher than that for ordinary negligence,

> the common carrier is regarded as a practical insurer of the goods against all losses of whatever kind with the exception of (1) those arising from what is known as an act of God, and (2) those caused by the public enemy; to which modern times have added (3) those arising from the act of the public authority, (4) those arising from the act of the shipper, and (5) those arising from the inherent nature of the goods.[164]

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160. *Id.*

161. *See, e.g.*, Liability Convention Records, U.N. Doc. A/Ac.105/C.2/SR.29-37, at 27 (1964), *reprinted in* 3 MANUAL ON SPACE LAW 437, 438 (N. Jasentuliyana & R. Lee eds. 1981). *See generally* 3 MANUAL ON SPACE LAW 207-594 (N. Jasentuliyana & R. Lee eds. 1981) (contains draft proposals and meeting records for the Liability Convention from 1962 to 1971).

162. *See* Simmons, *The Burden on the Common Carrier of Goods*, 113 LAW J. 166, 166 (1963). *See generally* R. SIGMON, MILLER'S LAW OF FREIGHT LOSS AND DAMAGE CLAIMS 59-269 (4th ed. 1974) (discussion of specific phases of common carrier liability). Despite the long development of the common law of carriage, some commentators have advocated abandonment of common carriage as an outdated, inefficient, and expensive transportation system. *See, e.g.*, Farmer, *The Case Against Common Carriage*, 31 I.C.C. PRAC. J. 682 (1964).

163. Grauer v. State, 15 Misc. 2d 471, 475, 181 N.Y.S.2d 994, 998 (N.Y. Ct. Cl. 1959).

164. R. HUTCHINSON, LAW OF CARRIERS 199 (2d ed. 1891) *quoted in* R. SIGMON, *supra* note 156, at 60; *see also* Simmons, *supra* note 162, at 167-68 (discussion of the few

A private carrier or contract carrier, as opposed to a common carrier, does not undertake to carry for all persons indiscriminately but only for those with whom he wishes to contract:

> Subject to statutory restrictions, state or federal, concerning performance of a transportation service none of which are applicable here, a person has the right to engage in the business of a private carrier. He asserts that right when, seeking all potential business as avidly as any other businessman desirous of a profit, it is yet his practice to treat each individual shipment on a separate basis and accept or reject it as wished and on terms and at rates satisfactory to him at the time.[165]

"[T]he liability of a private or contract carrier is precisely that of a bailee for hire who must answer only for loss or injury resulting from failure to use ordinary care, or conversely, is responsible for ordinary negligence."[166] Thus, a private or contract carrier is held to the traditional negligence standard of due care.

During the early years of the space transportation era it is doubtful that a space carrier would be considered a common carrier. Space carriers are not likely to hold themselves out to the public to transport goods into space for all persons. Instead, the carriers will likely contract separately for each shipment into space and set the rate according to the nature of the shipment and the orbit of its destination.[167] This practice of contracting each shipment on a separate basis is one factor indicating that a transportation company is a private carrier rather than a common carrier.[168] Additionally, space carriers are more likely to be considered private carriers because they will tend to serve a

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excepted perils for which a common carrier is not held liable).

165. Home Ins. Co. v. Riddell, 252 F.2d 1, 4 (5th Cir. 1958); *see also* Campbell, *The Contract Carrier, A History of the Concept*, 29 I.C.C. PRAC. J. 952 (1962) (discussion of the historical development of the contract carrier); Chiang, *The Characterization of a Vessel as a Common or Private Carrier*, 48 TUL. L. REV. 299 (1974) (discussion of factors considered in determining whether a water carrier is a common or private carrier); Davis, *Common or Contract Carrier?—The "Circle" Circle*, 47 IOWA L. REV. 637 (1962) (discussion of the analysis of several cases in determining whether a transportation company was a common or contract carrier).

166. Bigley Trucking Co. v. United States, 149 F. Supp. 141, 144 (Ct. Cl. 1957); *see* Weiss Bros. Stores, Inc. v. De Martis, 14 Misc. 2d 522, 523-24, 179 N.Y.S.2d 723, 724-25 (N.Y. Sup. Ct. 1958).

167. NASA, for example, completes a detailed launch agreement for each contract of carriage on the space shuttle. See S. GOROVE, 1 UNITED STATES SPACE LAW § 1.A.7, at 7-157 (1982) for a sample launch agreement between the United States represented by NASA and Satellite Business Systems.

168. *See, e.g.*, Home Ins. Co. v. Riddell, 252 F.2d 1, 4 (5th Cir. 1958).

unique limited class of persons—satellite users—rather than the public at large.[169] NASA has already announced that they consider the space shuttle a private carrier rather than a common carrier.[170]

Presumably, absent contrary state or federal regulation,[171] space carriers could remain private carriers even in a well-developed space transportation industry if they contracted separately for each carriage and did not hold themselves out to the public to transport goods or persons into space indiscriminately. Although the level of business activity will have significantly increased in a well-developed space transportation system, the quantity or extent of business is not a factor in determining whether the company is a common carrier.[172] Therefore, as private carriers, space transportation companies would be subject to liability based upon negligence.

C. Contractual Limitations on Liability

Regardless whether a space transportation company is considered a common carrier or a private carrier, the firm can limit by contract its liability to its customers for loss or damage.[173] A

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169. *See, e.g.*, Phillips v. Public Serv. Comm'n, 127 Pa. Super. 341, 348, 191 A. 641, 644 (1937).

170. *Space Shuttle Operational Planning, Policy and Legal Issues, Hearings Before the Subcomm. on Space Science and Applications of the House Comm. on Science and Technology*, 96th Cong., 1st Sess. 122-27, 130-31 (1979) (memorandum from Gerald J. Mossinghoff, Deputy General Counsel to General Counsel, Appendix A to testimony of S. Neil Hosenball, General Counsel, National Aeronautics and Space Administration).

171. *See, e.g.*, Sorkin, *Changing Concepts of Liability*, 17 FORUM 710 (1981) (discussion of the development of the common law of carriers and the effect statutes and regulations can have on the liability of carriers).

172. *See* Cushing v. White, 101 Wash. 172, 181-82, 172 P. 229, 232 (1918).

173. The public policy against contracts of adhesion might limit the ability of a space carrier to eliminate his liability by contract. A contract of adhesion is generally a standard form contract imposed by a party of superior bargaining power upon a substantially weaker party who has no real opportunity to bargain for the actual terms of the contract. *See* Bolgar, *The Contract of Adhesion: A Comparison of Theory and Practice*, 20 AM. J. COMP. L. 53, 54-55 (1972); *see also* Dauer, *Contracts of Adhesion in Light of the Bargain Hypothesis: An Introduction*, 5 AKRON L. REV. 1 (1972) (discussion concluding that the adhesive aspects of standard form contracts could be eliminated by a "rational merchant disclosure/behavior system" to provide consumers with a basis for comparative shopping). Although courts have found in rare situations contracts of adhesion in a commercial setting, generally, adhesive contracts asppear in consumer, rather than commercial, transactions. *See* Sybert, *Adhesion Theory in California: A Suggested Redefinition and Its Application to Banking*, 11 LOY. L.A.L. REV. 297, 303 (1978). Therefore, it is unlikely that a space transportation contract would be considered one of adhesion since a substantial bargaining disparity usually would not exist in the sophisticated

common carrier may contractually limit or eliminate any liability except that resulting from its own negligence.[174] A private carrier, on the other hand, may contract against all liability, even that resulting from its own negligence.[175] Similarly, a common carrier, which is acting as a private carrier, may limit by contract all liability even that resulting from its own negligence.[176]

Since space transportation companies are likely to be considered private carriers, they will be able to limit or eliminate entirely by contract their liability to their customers. NASA's space shuttle program, for example, purports to exempt by contract the United States Government from liability for any damage or loss to the payloads, even damage through the fault of NASA.[177] Therefore, users of private space transportation systems will be accustomed to limitation of liability in the era of the private space carriers.

The effect of space carriers' limiting or eliminating their liability will be the development of a system of insurance coverage for space shipments. Because NASA limits the liability of the United States Government, the space insurance industry has already been established.[178] For a premium of only $70,000 to $100,000 a shipper of goods into space can obtain $500 million worth of coverage for damage to the launcher and the goods and

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commercial setting of launch contract.

174. *See* R. SIGMON, *supra* note 162, at 61.

175. *See* Mulcahy, *Motor Carrier Cargo Liability—An Overview*, 49 I.C.C. PRAC. J. 257, 264 (1982).

176. *See, e.g.*, Santa Fe, P. & P. Ry. v. Grant Bros., 228 U.S. 177, 185 (1913); Chicago, M. & St. P. Ry. v. Wallace, 66 F. 506, 511 (7th Cir. 1895).

177. 14 C.F.R. § 1214.106 (1982) states:

> The price does not include a contingency or premium for damage that may be caused to a payload through the fault of the U.S. Government or its contractors. The U.S. Government, therefore, will assume no risk for damage or loss to the user's payload. The users will assume that risk or obtain insurance protecting themselves against that risk.

See also 1 S. GOROVE, *supra* note 167, § 1.A.7, at 38-50 (article V of sample launch agreement providing that the user insures his payload and that the user not make any claim against the United States Government for damage for any delay).

178. *$1 Billion Insurance Coverage Purchased*, AVIATION WEEK & SPACE TECH., Nov. 15, 1982, at 18, 18. For the first commercial flight of the space shuttle, Satellite Business Systems and Telesat Canada each purchased $500 million in liability insurance to cover damage to the shuttle, damage to the satellite payload, and failure to attain proper orbit. *Id.; see also* Smith & Weigend, *Third Party Liability Insurance for the Space Shuttle*, SATELLITE COMM., April 1979, at 22 (general discussion of space shuttle insurance).

failure to attain a proper orbit.[179] Initially, the premium may cost more for private carriers because they will not yet have been able to establish themselves as dependable space carriers. In addition to providing insurance for persons shipping goods into space, the insurance industry will need to provide third party liability insurance for the space carriers themselves. These premiums could also be rather expensive because of the possibility of significant injury to persons and property on earth.

The problem of cost prohibitive insurance premiums for space carriage could be alleviated by enactment of federal legislation similar to the Price-Anderson Act,[180] which was designed to aid the nuclear power industry. When Congress enacted the Price-Anderson Act in 1957 the emerging private nuclear power industry was in much the same position as the private space transportation industry is today. Prior to 1954 the federal government had held an absolute monopoly on atomic energy development.[181] The Atomic Energy Act of 1954[182] ended the government monopoly and attempted to encourage the development of atomic energy by private industry.[183] The private sector, however, was unwilling to invest heavily in the new technology, in part because of enormous potential liability it would incur under traditional tort law in the event of a serious nuclear accident.[184] Thus, Congress passed the Price-Anderson Act with two principal goals: protection of the public by assuring the availability of funds to satisfy accident claims, and protection of the nuclear

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179. *See $1 Billion Insurance Coverage Purchased*, *supra* note 178, at 18. The cost of the premium is very low because NASA has operated with an excellent track record of trouble-free deliveries. *See id.*

180. Price-Anderson Act, Pub. L. No. 85-256, § 4, 71 Stat. 576 (1957), *as amended by* Act of Sept. 29, 1965, Pub. L. No. 89-210, § 1, 79 Stat. 855 (1965) and Act of Dec. 31, 1975, Pub. L. No. 94-197, §§ 2-14, 89 Stat. 1111 (1975) (codified at 42 U.S.C. § 2210 (1976)); see *AEC Staff Study of the Price-Anderson Act: Part I*, 16 ATOM. ENERGY L.J. 205 (1974) and *AEC Staff Study of the Price-Anderson Act: Part II*, 16 ATOM. ENERGY L.J. 297 (1975), for a thorough discussion of the Price-Anderson Act; *see also* Murphy, *The Problems of Protection Against Atomic Hazards*, 1958 INS. L.J. 583 (discussion of the various factors leading to passage of the Price-Anderson Act).

181. *See* Atomic Energy Act of 1946, ch. 724, §§ 1, 6, 80 Stat. 755 (1946) (current version at 42 U.S.C. §§ 2011, 2121 (1976)).

182. Atomic Energy Act of 1954, ch. 1073, 68 Stat. 919 (1954) (current version at 42 U.S.C. §§ 2011-2282 (1976)).

183. *See* S. REP. No. 296, 85th Cong., 1st Sess. 1 *reprinted in* 1957 U.S. CODE CONG. & AD. NEWS 1803, 1803.

184. *See id.; see, e.g., Hearings on Governmental Indemnity and Reactor Safety Before the Joint Committee on Atomic Energy*, 85th Cong., 1st Sess. 147-48, 156 (1957) (statement of Francis K. McCune, Vice-President of General Electric Co.).

industry by removing the threat of tremendous potential liability.[185] Opponents of the Act argue that it is a government subsidy designed to protect the nuclear power industry and to afford little actual protection to the public.[186]

The Price-Anderson Act established a program of government indemnification and liability limitation for the nuclear industry. As a condition for obtaining a license[187] and construction permit,[188] the Act requires the licensee (the utility) to furnish financial protection in the form of insurance in amounts determined by the Nuclear Regulatory Commission.[189] The Act also requires the Commission to provide indemnification of up to $500 million for each nuclear incident.[190] Additionally, the liability for a nuclear accident is limited to the aggregate of the Commission's indemnity and the amount of private insurance required.[191]

The space transportation industry is in a position similar to the private nuclear energy industry in 1957. Since the beginning of the space age the federal government has held an absolute monopoly on the carriage of goods into space.[192] Now that a private space transportation system is emerging, enactment of federal legislation similar to the Price-Anderson Act would encourage the development of the industry while alleviating the risk of high potential liability from space transportation accidents. Such legislation could ensure reasonable premiums for space carriers by limiting their third party liability and by pro-

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185. *See* S. REP. No. 454, 94th Cong., 1st Sess. 1, *reprinted in* 1975 U.S. CODE CONG. & AD. NEWS 2251, 2251; S. REP. No. 1605, 89th Cong., 2d Sess. 6, *reprinted in* 1966 U.S. CODE CONG. & AD. NEWS 3201, 3206; S. REP. No. 296, 85th Cong., 1st Sess. 9, *reprinted in* 1957 U.S. CODE CONG. & AD. NEWS 1803, 1811.

186. *See, e.g.*, Brauer, *The Price-Anderson Act. A Constitutional Meltdown of Tort Liability*, 8 HASTINGS CONST. L.Q. 731 (1981). The author argues that the Act shifts the burden of loss for the nuclear industry to the victims of nuclear accidents. Thus, he contends that the present compensation system subverts the basic tenet of the common law requiring that one be responsible for the full consequences of one's acts. *Id.* at 396; *see also*, Burcat, *Uncompensated Victims of Low-Level Radiation: Unnecessary Hostages of the Price-Anderson Act Debate*, 15 FORUM 847 (1980) (discussion of the Price-Anderson Act, concluding that most latent disease victims of low-level radiation will go uncompensated because they will be unable to prove cause in fact under the Act's standards).

187. 42 U.S.C. § 2131 (1976).

188. 42 U.S.C. § 2235 (1976).

189. 42 U.S.C. § 2210(a) (1976).

190. 42 U.S.C. § 2210(e) (1976).

191. *Id.*

192. *See supra* notes 3-9 and accompanying text.

viding government indemnification for space accidents.

Federal legislation similar to the Price-Anderson Act could also be enacted to guarantee reasonable premiums for persons shipping goods into space. Congress has already enacted legislation to limit the liability of users of the space shuttle. The National Aeronautics and Space Administration Authorization Act, 1980,[193] added a new section 308 on "Insurance and Indemnification" to the National Aeronautics and Space Act of 1958.[194] The new Act authorizes NASA to use its appropriations to acquire liability insurance for shuttle users who otherwise could not obtain the necessary insurance coverage.[195] Additionally, the new provision allows the United States to indemnify the user against claims by third parties to the extent such claims are not compensated by the liability insurance of the user.[196] Since persons shipping goods into space on private carriers may be faced with higher premiums, legislation similar to section 308 may be necessary to enable these persons to acquire the proper liability in-

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193. National Aeronautics and Space Administration Authorization Act, 1980, Pub. L. No. 96-48, § 6, 93 Stat. 345, 348 (1979) (codified at 42 U.S.C. § 2458b (Supp. V 1981)). See Mossinghoff, *Managing Tort Liability Risks in the Era of the Space Shuttle*, 7 J. SPACE L. 121 (1979) and Sloup, *Liability and Insurance Aspects of the Space Transportation System Under the New Section 308 of the National Aeronautics and Space Act*, 4 ANNALS AIR & SPACE L. 639 (1979), for discussions of the new insurance and indemnification section.

194. National Aeronautics and Space Administration Act of 1958, 42 U.S.C. §§ 2451-2484 (1976 & Supp. V 1981).

195. *Id.* § 2458b(a). The relevant part of the section reads:

> The Administration is authorized on such terms and to the extent it may deem appropriate to provide liability insurance for any user of a space vehicle to compensate all or a portion of claims by third parties for death, bodily injury, or loss of or damage to property resulting from activities carried on in connection with the launch, operations or recovery of the space vehicle. Appropriations available to the Administration may be used to acquire such insurance, but such appropriations shall be reimbursed to the maximum extent practicable by the users under reimbursement policies established pursuant to section 2473(c) of this title.

196. *Id.* § 2458b(b). The relevant part of the section reads:

> Under such regulations in conformity with this section as the Administrator shall prescribe taking into account the availability, cost and terms of liability insurance, any agreement between the Administration and a user of a space vehicle may provide that the United States will indemnify the user against claims (including reasonable expenses of litigation or settlement) by third parties for death, bodily injury, or loss of or damage to property resulting from activities carried on in connection with the launch, operations or recovery of the space vehicle, but only to the extent that such claims are not compensated by liability insurance of the user: *Provided*, That such indemnification may be limited to claims resulting from other than the actual negligence or willful misconduct of the user.

surance despite higher premiums for private space carriers. The government agency administering the program[197] could require that the person for whom the coverage is purchased reimburse the agency to the maximum extent practicable. Such a program would not only foster the development of private space carriers but also encourage the growth of commercial operations in space.

Commentators have recognized that governmental reduction of the risk of investing in new technology is often necessary to encourage the development of such technology.[198] Therefore, statutes that limit the risks of carriers and shippers investing in the new space transportation industry are appropriate means of ensuring the growth of new technology.[199] The proper balance between unlimited risk and total freedom from risk in the development of new technology was discussed by Professor Milton Katz:

> The risk should not be so great as to discourage research, development, or investment in new technology. It should be large enough, however, to impel industrial enterprises to take account of total systems effects in their research and development. They should be stimulated to apply the resources of science and technology to the elimination of harmful side effects as well as the achievement of the desired initial objective.[200]

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197. Since NASA is primarily a research and development agency, the responsibility for a government guaranteed insurance program should be placed with another agency. Something similar to a Space Industrialization Corporation, suggested in the Space Industrialization Acts of 1979 and 1980, could perhaps best administer the program. *See supra* notes 57-59 and accompanying text.

198. *See, e.g.*, Katz, *The Function of Tort Liability in Technology Assessment*, 38 U. CIN. L. REV. 587, 662 (1969).

199. For an extensive discussion of the effect of law on science and technology and the effect of science and technology on the law, see Gibbons, *The Relationship Between Law and Science*, 22 IDEA 43, 159, 227, 283 (1980-1982). *See also* Bazelon, *Coping with Technology Through the Legal Process*, 62 CORNELL L. REV. 817 (1977) and Bazelon, *Risk and Public Policy: "To Live and . . . Become Bold,"* 14 REV. HILLS B. A.J. 261 (1980) (articles by David L. Bazelon, Senior Circuit Judge of the United States Court of Appeals for the District of Columbia, discussing the role of the courts in scrutinizing and monitoring the decision-making process of administrative agencies in the law/technology interface).

200. Katz, *supra* note 198, at 662. Professor Katz concluded that "[t]he cost burden should be spread widely enough to avoid penalizing any single enterprise that happens to become the target of a lawsuit or the locus of an accident which might have befallen any firm within the industry." *Id.* He added that the cost "should not be spread so widely, however, as to nullify the incentive to all firms within the industry to take more sensitive account of harmful side effects and make a more determined and imaginative attempt to eliminate them." *Id.*

Therefore, the limited liability and indemnification provisions for the private space transportation industry, or for any other new technology, should be sufficient to encourage the development of the industry but not so generous as to discourage technical research of means to further reduce the risks.

D. National Regulation and its Effect on the Liability of Space Carriers

National regulations may affect the liability of a private space carrier to his customer. National regulation is mandated by the Outer Space Treaty of 1967.[201] Under the treaty nations bear the international responsibility for their activities in outer space whether such activities are carried on by governmental agencies or by nongovernmental entities.[202]Therefore, national governments must authorize and continually supervise the activities of nongovernmental entities.[203]

In the United States the Federal Aviation Administration is the only agency that currently regulates the operations of private space transportation companies. The FAA regulations supervise the launching of rockets[204] in airspace.[205] Under the regulations, within twenty-four to forty-eight hours before a launch, the person conducting the launch must provide the nearest FAA Air Traffic Control facility with the names and addresses of the operators, the number of rockets to be launched, the size and weight of each rocket, the maximum altitude expected, the location of the launch, and the date, time and duration of the opera-

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201. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205 [hereinafter cited as Outer Space Treaty]. The Outer Space Treaty was approved within a decade after the launch of the first Sputnik when the many uses of the outer space environment had been identified. The purpose of the treaty was to prohibit claims of sovereignty in outer space and to ensure the peaceful use of outer space for the benefit of all mankind. *See generally* Dembling, *Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, in 1 MANUAL ON SPACE LAW 1 (N. Jasentuliyana & R. Lee eds., 1979) (discussion of the history and provisions of the Outer Space Treaty).

202. Outer Space Treaty, *supra* note 201, art. VI.

203. *Id.*

204. Federal Aviation Administration regulations have defined a rocket as "an aircraft propelled by ejected expanding gases generated in the engine from self-contained propellants and not dependent on the intake of outside substances. It includes any part which becomes separated during the operation." 14 C.F.R. § 1.1 (1982).

205. *Id.* § 101.21.

tion.[206] FAA regulations also prohibit rocket launches in controlled airspace, within five miles of any airport, into any cloud or obscuring cloud cover, when horizontal visibility is less than five miles, within 1,500 feet of any person or property not associated with the launch, between sunset and sunrise, and in any manner that creates a collision hazard with other aircraft.[207] Thus, the FAA regulations primarily ensure the protection of other aircraft rather than regulate the commercial operations of a carrier in space.

Because the FAA regulations do not adequately supervise the activities of nongovernmental entities in space, a new regulatory regime must be established to oversee the operations of private carriers in space. Such regulation could be administered by NASA, by the Interstate Commerce Commission,[208] by the Federal Aviation Administration,[209] or by some new space regulatory agency. Since NASA was intended to be a research and development agency rather than a regulatory agency,[210] supervision of space carrier operations should not be delegated to NASA. Also, space presents special problems and legal issues such as potential international liability. Thus, the regulation of private space operations should not be assigned to an existing agency such as the ICC or the FAA. Therefore, a new space regulatory agency would be the best means of regulating nongovernmental activities in space.

An organization such as the Space Industrialization Corporation[211] could be created to encourage commercial operations in space and to regulate such activity. Whatever agency does supervise private space activity, it must realize that private commercial activity in space is a new industry that needs incentive to develop in addition to reasonable safety regulations. Therefore, Congress and the regulatory agency should refrain from imposing legislation and regulation on the new industry that would unduly discourage firms from entering the industry.

One additional area of consideration in determining the liability of a private space carrier to his customer is the effect of a

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206. *Id.* § 101.25.

207. *Id.* § 101.23.

208. The Interstate Commerce Commission regulates most interstate carriers under the Interstate Commerce Act, 49 U.S.C. §§ 10101-11917 (Supp. V 1981).

209. The Federal Aviation Administration regulates air carriers under the Federal Aviation Act, 49 U.S.C. §§ 1301-1552 (1976 & Supp. V 1981).

210. *See supra* notes 72-76 and accompanying text.

211. *See supra* notes 57-59 and accompanying text.

violation of a space safety rule or regulation. Legal commentators have disagreed on whether such a violation constitutes negligence per se or is merely evidence of negligence.[212] The *Restatement (Second) of Torts,* for example, adopts the view that a court may find negligence per se when the defendant violates a statute or regulation if the plaintiff is of the class the legislation intended to protect, if the interest invaded was to he protected by the statute, if the legislation intended to protect that interest from the kind of harm which resulted, and if the statute sought to protect that interest against the particular hazard from which the harm resulted.[213] Other commentators conclude that a violation of an administrative safety measure should result in a presumption of a failure to use due care.[214] The defendant can rebut this presumption and require the court to try the negligence issue by the reasonably prudent person standard if he can demonstrate affirmative grounds for questioning the suitability of administrative judgment as a criterion for due care.[215]

Courts have also differed on the effect of statutory or regulatory violations. For example, some jurisdictions have held pilots negligent as a matter of law when an accident arose from a violation of an FAA safety rule.[216] Other courts have ruled that the violation of the safety rule can be used only as evidence of negligence.[217]

It is difficult to determine what effect a violation of a safety rule would have on a space carrier. The jurisdiction in which the

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212. The leading article on the doctrine of negligence per se is Thayer, *Public Wrong and Private Action,* 27 HARV. L. REV. 317 (1914). Professor Thayer argued that a violation of a criminal statute should result in negligence per se because it would be against the very nature of the reasonably prudent and law-abiding citizen to set his own opinion up against that of the duly constituted lawmaking body of the community. *Id.* at 322. *See generally* 2 F. HARPER & F. JAMES, THE LAW OF TORTS § 17.6, at 994-1014 (1956) (discussion of whether violation of a statute should result in a finding of negligence per se). W. PROSSER, *supra* note 95, § 36, at 190-204 (discussion of negligence per se resulting from the violation of a statute).

213. RESTATEMENT (SECOND) OF TORTS § 286 (1965).

214. *See, e.g.,* Morris, *The Role of Administrative Safety Measures in Negligence Actions,* 28 TEX. L. REV. 143, 166 (1949). California has similarly held that a violation creates a presumption of negligence, which may be rebutted by demonstrating an adequate excuse. *See* W. PROSSER, *supra* note 95, § 36, at 201; *see, e.g.,* Lightenburger v. United States, 298 F. Supp. 813, 838 (C.D. Cal. 1969), *rev'd on other grounds,* 460 F.2d 391 (9th Cir.), *cert. denied,* 409 U.S. 983 (1972).

215. *See* Morris, *supra* note 214, at 166-67.

216. *See, e.g.,* Gatanby v. Altoona Aviation Corp., 407 F.2d 443, 446 (3d Cir. 1968).

217. *See, e.g.,* Citrola v. Eastern Air Lines, Inc., 264 F.2d 815, 818 (2d Cir. 1959); Sleezer v. Lang, 170 Neb. 239, 253-54, 102 N.W.2d 435, 445 (1960).

suit is brought could be a determinative factor on whether the carrier committed negligence per se. Additionally, the facts and circumstances of each case would be relevant in finding negligence per se if the rule or regulation was intended to protect the shipper of goods from the harm caused by the breach of the safety rule. Because the effect of a violation of a safety regulation is an uncertain area, space carriers would be advised to carefully adhere to any space regulatory rules to avoid a finding of negligence per se.

VI. Conclusion

The era of the private space carrier is at hand. The technological benefits and economic advantages of commercial operations in space will soon lead to the entry of private firms in the space transportation business. Legal risks and tort liability must be defined for enterprises entering this new industry of space transportation. The tort liability of such carriers for damage to the goods they carry should be based on a standard of negligence rather than strict liability because space carriage is not an abnormally dangerous activity to the goods being carried and because space carriers are not common carriers. The space insurance firms should be prepared for contractual limitations of liability imposed by private carriers since space insurance developed in the framework of total governmental exclusion of liability. Finally, any governmental supervision of the private space carrier industry should encourage the development of commercial operations in space as well as regulate the industry.

Charles L. Deem